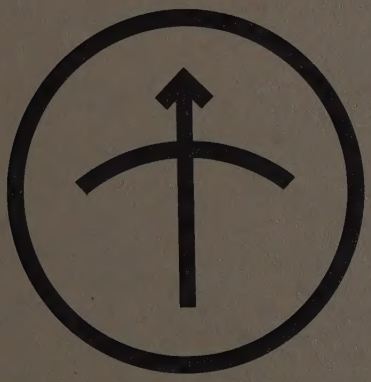
MODEL 210-S
STANDARD F.M. SIGNAL GENERATOR

Operating INSTRUCTIONS



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MEASUREMENTS
A McGRAW-EDISON DIVISION
BOONTON NEW JERSEY

MODEL 210-S

STANDARD F.M. SIGNAL GENERATOR

Operating INSTRUCTIONS

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BOONTON NEW JERSEY

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Additional information with regard to the applications and maintenance of this equipment will be available from time to time. Users of the Model 210-S are urged to discuss their problems with us and to suggest such modifications as might make the instrument more adaptable to their special requirements.

Maintenance difficulties should be reported to Measurements Corporation before proceeding with actual repairs, since, through our familiarity with the instrument, we are able to suggest the appropriate repair procedure.

Engineering Department

MEASUREMENTS CORPORATION

Boonton, New Jersey

U. S. A.

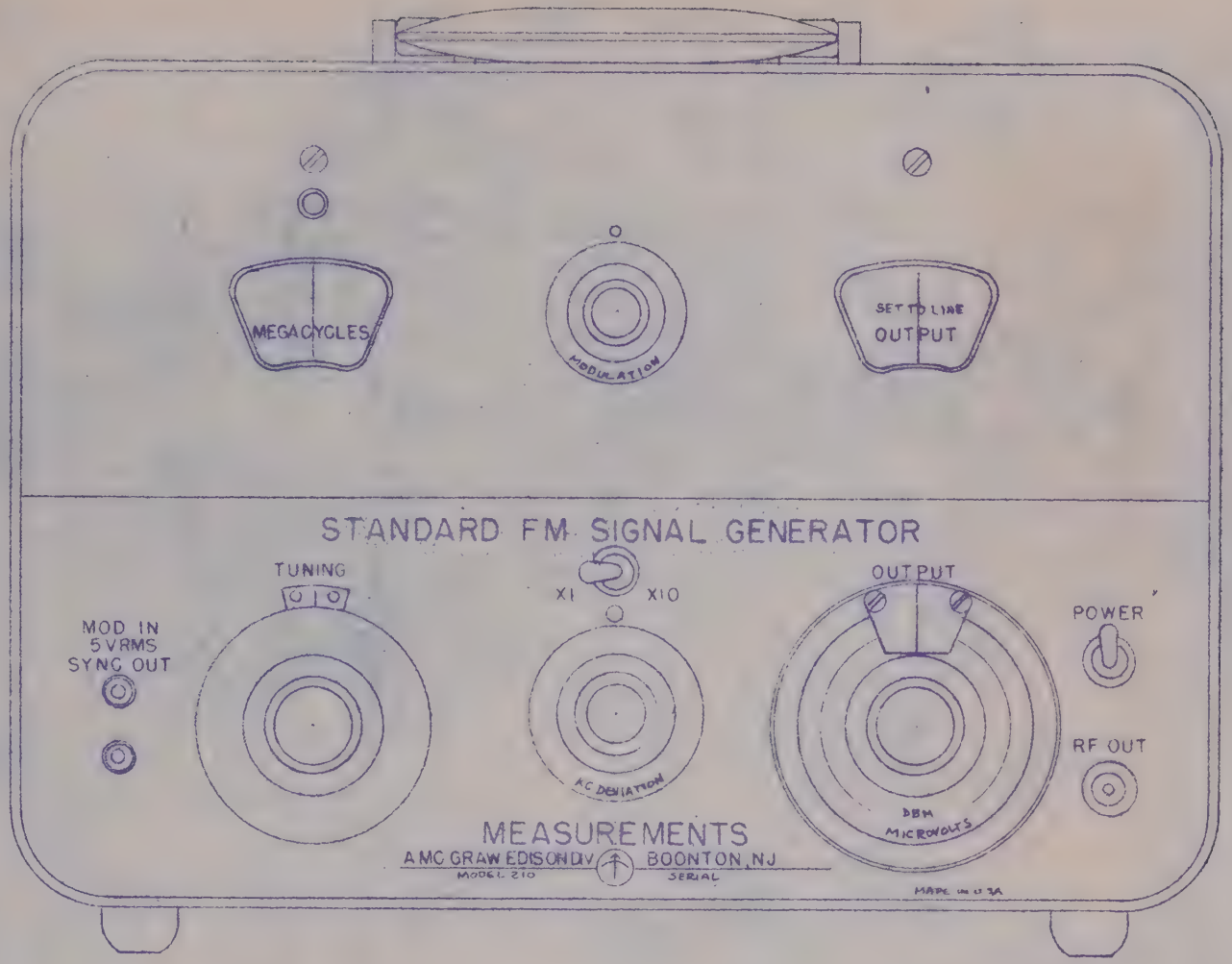

Figure 1. Front View of Model 210 Standard FM Signal Generator.

CHAPTER 1

INTRODUCTION

SECTION I

GENERAL

1. SCOPE OF MANUAL

a. This manual describes the basic operation, construction, and maintenance of the Model 210-S Standard Signal Generator. Following the text of the manual are two appendices. Appendix I describes the recommended procedure for preparing the instrument for prolonged storage or reshipment. Appendix II contains an Identification Table of Replaceable Parts, listing the reference symbols, name description, and drawing number of each part required for maintenance.

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SECTION II

DESCRIPTION AND DATA

2. GENERAL

a. The Model 210-S is a frequency-modulated signal generator operating directly at carrier frequency. Since no beat-frequency oscillators are involved, there are no spurious components present in the output other than small amounts of carrier harmonics.

b. Though designed as a laboratory standard, the Model 210-S is also suitable for use in production testing.

3. TECHNICAL CHARACTERISTICS

a. Carrier Frequency Range:

1. 24 to 52 megacycles.

2. Individually calibrated dial with ± 0.5% accuracy.

b. Tuning:

1. A vernier frequency dial having 100 divisions is geared to the main dial.

2. Electronic tuning of ± 0-15 and ± 0-150 Kc is provided by the calibrated frequency deviation dial.

c. Output Voltage:

1. An output of 0.1 to 100,000 microvolts (-7 to -127 DBM) across a 50-ohm termination.

d. Carrier Output System:

1. The mutual inductance attenuator is of the wave guide below cutoff type. It has a 50-ohm source impedance and is directly calibrated in microvolts and DBM when terminated in 50 ohms. If a high-impedance load is used, a 50-ohm connecting cable terminated in 50 ohms, as close as possible to the load, should be used. Measurements 80ZH4 terminated cable is recommended for this purpose.

2. The output reference level is continuously monitored using a barretter bridge system. The 100,000 microvolt reference level is accurate to ± 5%.

3. The shielding and filtering of the Model 210 is excellent and no trouble should be encountered in making accurate measurements at levels from 100,000 microvolts to 0.1 microvolt.

e. Modulation System:

1. This signal generator is designed for either frequency modulation or CW operation.

2. Frequency deviations of 0-15 and 0-150 Kc are directly available from the internal 400 cycle or 1000 cycle oscillator. The internal oscillator also supplies 5 volts in series with 100,000 ohms for synchronizing purposes at the external modulation binding posts.

3. Modulation frequencies from D.C. * to 100 Kc at a 5 volts RMS level may be applied to the external modulation input binding posts. The input impedance at this point is approximately 10,000 ohms.

NOTE: * A D-C voltage of 1.414x5 = 7.07 volts is required for correct calibrated deviation when using D.C.

e. Modulation System: - Continued

4. The frequency response of the modulator is within 1 db from D.C. to 50,000 cycles and down approximately 3 db at 100 Kc. Transient response is excellent.

5. Harmonic distortion of the frequency modulation is less than 2% at 75 Kc deviation and correspondingly less at lower deviation.

6. Spurious residual FM is 60 db below 75 Kc deviation.

f. Power Supply:

1. 117 volts, 50-60 cycles.

2. Power input 45 watts.

3. Fuse 1 Type MDL 8/10 amp.

4. COMPONENTS SUPPLIED

a. See Table I. Table of Components.

TABLE I. TABLE OF COMPONENTS

Quan.	Description	Dimensions			Unit Weight	Volume Cu. Ft.
		Height	Width	Depth		
1	Model 210-S Standard Signal Generator.	11"	14"	7-1/4"	Approx. 22 lbs.	0.65
1	Manual of Operating Instructions.					
1	Tube, 6AF4A, installed.					
2	Tubes, 5654 (6AK5), installed.					
1	Tube, 12BH7, installed.					
1	Tube, 6X4, installed.					
1	Tube, 0A2, installed.					

5. EXPORT PACKAGING

a. Packed for export, the Model 210-S is packed in a wooden box.

TABLE II. EXPORT PACKAGING DATA

Number of Packages	Height	Width	Depth	Weight	Volume Cu. Ft.
1	17"	22"	17"	60#	3.7

CHAPTER 2

OPERATING INSTRUCTIONS

SECTION I

SERVICE UPON RECEIPT OF EQUIPMENT

6. UNPACKING

a. Take care when unpacking or handling the equipment. Follow the procedure outlined below when unpacking the instrument.

(1) Place the packing case in a location where it can be opened easily.

(2) Extract nails with a nail puller and remove the top of the packing case, or slit, if packed in carton.

(3) Lift the signal generator from the packing case and remove the paper wrapping.

(4) Inspect the case and controls on the front panel for possible damage during shipment.

7. PRELIMINARY PRECAUTIONS

a. Connect the Model 210-S to a power source of 117 volts, 50-60 cycles, with a capacity of at least 45 watts.

b. During operation, make certain there is ample clearance between the rear of the case and the wall, or other object, to provide sufficient ventilation.

SECTION II

CONTROLS AND INSTRUMENTS

8. TUNING Dial

a. The vernier TUNING knob and dial on the lower left side of the front panel sets the fundamental carrier frequency. This frequency is directly indicated under the fiducial line in the panel opening directly above.

9. K.C. DEVIATION Dial

a. The K.C. DEVIATION dial is just to the right of the TUNING knob. It is direct reading and calibrated from 0 to 15 Kc deviation.

10. X1 - X10 Switch

a. This switch which is directly above the K.C. DEVIATION dial multiplies the deviation by X1 or X10, making possible a total deviation of 150 Kc.

11. MODULATION Function Switch

a. This switch is located directly above the deviation multiplier X1 - X10 switch. Its purpose is to supply the carrier signal with the type of modulation desired.

b. When the MODULATION switch is in the - or + INC. position, the K.C. DEVIATION dial serves as a carrier frequency vernier, shifting the carrier frequency lower or higher in frequency than its initial dial setting. This incremental carrier shift is directly indicated from the K.C. DEVIATION dial and the X1 - X10 switch. This feature is extremely useful when plotting frequency response and discriminator slope characteristics.

c. The EXT. position allows external modulation at 5V RMS level to be applied to the oscillator via the two binding posts MOD. IN - SYNC. OUT, located at the extreme lower left corner of the panel. Modulation frequencies from D.C. to 100 Kc may be applied.

d. The OFF position removes all modulation and a pure CW signal is available.

e. The 400-cycle position applies 400-cycle FM modulation to the carrier. The deviation is directly indicated on the deviation dial and switch.

f. The 1000-cycle position applies 1000-cycle FM modulation to the carrier. The deviation is directly indicated on the deviation dial and switch.

g. NOTICE: When the MODUIATION switch is in the 400-cycle, or in the 1000-cycle position, the internal oscillator supplies 5 volts r.m.s. in series with 100,000 ohms at the MOD. IN - SYNC. OUT binding posts for oscilloscope sweep synchronization purposes.

12. OUTPUT Control

a. The OUTPUT control is a dual control consisting of a fiducial index and lever, and a knob and dial calibrated in MICROVOLTS and DBM, used to drive the piston attenuator.

b. The fiducial and lever are used to set the output reference level of 100,000 microvolts. The lever is moved clockwise or counterclockwise until the pointer of the OUTPUT meter is directly over the vertical zero-center reference line.

c. The OUTPUT knob and dial will then indicate the true output in microvolts or DBM when the type N, R.F. OUTPUT fitting, located in extreme lower right corner of the panel, is terminated in 50 ohms impedance.

13. POWER

a. The POWER switch, S1, located just above the R.F. OUTPUT fitting, controls the application of line voltage to the primary of the power transformer, T1.

14. FUSE

a. The FUSE, F1, located adjacent to the power cord on the bottom of the instrument case, serves to protect the instrument against overloads.

SECTION III

OPERATION

15. INSTALLATION AND ADJUSTMENT

a. The Model 210-S Standard Signal Generator is a portable electronic test instrument which requires no permanent installation. Sufficient clearance should be provided between the case and other objects to insure ample ventilation. No preliminary adjustments are required prior to operation.

16. PRELIMINARY OPERATIONAL CHECKS

a. Connect the power cord to a source of 117-volt, 50-60 cycle alternating current, and place the POWER switch in the ON position. Allow several minutes for the tubes to warm up.

b. Rotate the fiducial lever until the OUTPUT meter pointer rests on the line in the center of the meter scale.

17. SET-UP PROCEDURE

a. Follow paragraph 16a under "Preliminary Operational Checks".

18. OPERATION AND USE

a. Follow paragraph 16b under "Preliminary Operational Checks".

b. Set TUNING knob to desired carrier frequency and check OUTPUT meter. If the pointer does not fall on the center line, readjust the fiducial lever until it does.

c. Place MODULATION knob in either "400" or "1000" cycle position for the internal sine-wave audio signal source of either 400 or 1000 cycles. For other waveforms or other frequencies, an external signal source must be used. When using this external source, turn the MODULATION switch to the EXT. position. Then connect the signal to the EXT. MOD. binding posts. Adjust the signal amplitude to 5 volts r.m.s. (7.07 volts for D.C.)

d. Adjust the KC DEVIATION knob for the desired carrier frequency deviation.

e. Set OUTPUT index to bring the pointer of the OUTPUT meter to the center reference line. Then turn MICROVOLTS dial to desired output voltage.

NOTE:

The attenuator should preferably be adjusted in the following manner in order to minimize frequency shift due to attenuator adjustment.

1. Set the frequency to the approximate desired value.
2. Adjust the fiducial on the attenuator for a zero balance (SET TO LINE) on the OUTPUT meter.
3. Set the attenuator for an output of 50K microvolts (or lower if permissible).
4. Adjust the frequency to the exact desired value.

19. USE OF FREQUENCY-MODULATED OUTPUT

a. F.M. receiver testing.

b. Tuning range determination.

c. Sensitivity.

d. Co-channel interference.

e. Maximum undistorted output.

f. Output of receiver in connection with modulation frequency.

g. Selectivity.

h. Intermodulation Tests.

i. Square-wave testing.

j. Impulse noise susceptibility.

k. Random noise susceptibility.

l. Discriminator characteristics.

CHAPTER 3

MAINTENANCE INSTRUCTIONS

SECTION I

MAINTENANCE

20. GENERAL

a. Preventive maintenance procedure is not recommended for the Model 210-S. Critical adjustments may be disturbed by too frequent inspection on the part of personnel unfamiliar with the design of the Model 210-S, thus, causing errors in data that would be much more serious than an occasional operational failure.

b. If failure occurs, the instrument should be checked by the procedure outlined in Paragraph 16 (Preliminary Operational Checks). If trouble other than a defective tube is indicated, the instrument should be returned to Measurements Corporation.

c. For analyzing troubles, see Tables III and IV.

d. For removal of instrument from case, see paragraph 33.

TABLE III

TROUBLE SHOOTING CHART

TROUBLE	POSSIBLE CAUSE & REMEDY
Generator inoperative, pilot lamp not lit.	Fuse F1 may be open. Switch S1 defective.
Pilot lamp lights but no R.F. output.	Failure of 6X4 rectifier tube or 6AF4A oscillator tube.
R.F. output but no meter indication.	If meter pointer at center scale check R21 or M1. If off scale right or left, check RT3 or RT2. Warning! Exercise care in using an ohmmeter for this check. Currents in excess of 1 milliampere may permanently damage RT3 and RT2.
R.F. operates normally but no deviation in 400 or 1000 cycle position.	Check V3a and V3b. Also 3W 115V lamp RT1.
Deviation obtained but R.F. frequency off calibration.	Check reactance tubes V4 and V6.
Deviation distortion high.	If certain that distortion is from the generator and not the receiver, replace tubes V4 and V6. It is not advisable to touch DISTORTION ADJ. R25 unless elaborate test equipment is available. Ascertain that the distortion is not coming from the modulating source by using a low distortion, external modulation source.

TABLE IV

PRELIMINARY TUBE VOLTAGE CHART

TUBE		PLATE		SCREEN (or other Grids)		CONTROL GRID		CATHODE		HEATER	
No.	Type	Pin	Volts	Pin	Volts	Pin	Volts	Pin	Volts	Pin	Volts
V1	6X4	1 6	300 AC 300 AC	-	-	-	-	7	+320	3 4	0 0
V2	0A2	5	+145	-	-	-	-	2	-7.8	-	-
V3A) V3B)	12BH7	1 6	+30 +110	- -	- -	2 7	0 -7	3 8	+1.8 -6	4 & 5 9	6.3 AC 0
V4	5654	5	+140	6	+135	1	0	2 & 7	+4	3 4	0 +6.3
V5	6AF4A	1 & 7	+80	-	-	2 & 6	-10	5	0	3 4	0 +6.3
V6	5654	5	+140	6	+135	1	0	2 & 7	+4	3 4	0 6.3

REMARKS: D-C all voltage measurements taken with 20,000 ohm-per-volt d-c meter.
A-C voltages measured with 1000-ohms-per-volt a-c meter. Variations of ± 20% from these values may be normal.
Generator in normal operating conditions.
All voltages are measured with reference to the chassis ground.

CHAPTER 4

EQUIPMENT USED IN CONJUNCTION WITH MODEL 210-S

SECTION I

ACCESSORIES

21. RECOMMENDED ACCESSORIES

a. Measurements Corp. 80-ZH4 Output Cable terminated in a type N connector at one end and a pair of binding posts with 50-ohm resistor load at other end.

b. UG201/U type N to BNC Adapter.

22. RECOMMENDED AUXILIARY EQUIPMENT

a. Measurements Corp. Model 71 Square-Wave Generator.

b. Measurements Corp. Model 31 Intermodulation Meter.

c. Measurements Corp. Model 82 Standard Signal Generator.

d. Broad-band Oscilloscope.

CHAPTER 5

TECHNICAL SERVICE - MAINTENANCE INSTRUCTIONS

SECTION I

GENERAL

23. SCOPE

a. The purpose of this chapter is to acquaint operating and maintenance personnel with the theory of operation of the various circuits in the Model 210-S Standard Signal Generator and to describe recommended adjustment procedures.

b. Return the instrument to Measurements Corporation whenever repairs involving replacement of components are necessary.

SECTION II

CONDENSED THEORY OF OPERATION

24. GENERAL

a. The Model 210-S contains a variable-frequency r-f oscillator with a continuously variable frequency range covering a ratio of approximately 2 to 1.

b. The internal audio signal source is a dual tube R-C coupled oscillator which can be set at either 400 or 1000 cycles and is coupled to a reactance modulator.

25. R-F OSCILLATOR

a. The carrier frequency generator is a modified Colpitts Oscillator using a 6AF4A miniature triode.

b. The frequency of the oscillator is controlled by means of the split-stator condenser, C27, which permits a tuning ratio of approximately 2 to 1.

c. The oscillator is inductively coupled to a small pick-up loop in the attenuator. The degree of coupling between the oscillator and the pick-up loop determines the output voltage. The attenuator dial is calibrated in microvolts and DBM.

26. INTERNAL AUDIO SOURCE

a. The internal audio-frequency signal is generated by a modified Wien bridge R-C coupled oscillator which uses a 12BH7 dual triode. This oscillator is designed to produce a sine wave of low harmonic content.

b. The frequency of the oscillator is set at either 400 or 1000 cycles by means of the MODULATION function switch, S2.

c. The audio oscillator is connected to the reactance tube modulator via MODULATION switch S2, deviation multiplier switch X1 - X10, S3, deviation control, R18, and potentiometers R34 and R35.

d. A small amount of signal from the internal audio oscillator is also available at the EXT. MOD. input terminals for synchronizing purposes, when the MODULATION function switch, S2, is in the 400- or 1000-cycle position.

27. REACTANCE MODULATOR

a. Frequency modulation is obtained in the Model 210-S by means of reactance tubes, V4 and V6, which inject a reactive current into the oscillator tank circuit in proportion to the modulation signal applied to the grids of the reactance tubes. This reactive current shifts the oscillator frequency and thus produces frequency modulation.

b. DEV. CAL. adjustment R35 serves to adjust the initial calibration of the KC DEVIATION dial.

c. R34 is a potentiometer driven by the main frequency tuning capacitor, and in conjunction with R40, R41, R42 and R43, serves to keep the deviation level constant over the calibrated frequency range.

28. OUTPUT SYSTEM

a. The output system (see Fig. 2) consists of a piston type attenuator operating as a wave guide below cutoff. Attenuation is a function of the attenuator tube diameter and the calibrated travel of the pick-up loop which are held to close tolerances.

b. Coil L2 couples the magnetic field in the attenuator tube to the output fitting on the panel. R28 provides a source impedance of 50-ohms with a low VSWR.

c. Coil L3 serves to sample the magnetic field at mouth of the attenuator tube. It is adjustable and is linked mechanically to the OUTPUT dial index. Its purpose is to locate and maintain a constant reference magnetic field at the mouth of the attenuator.

d. Coil L3 and bolometer RT2 form one arm of a Wheatstone bridge. Any change in induced r-f current through L3 changes the resistance of RT2, thus unbalancing the bridge and producing a deflection of the OUTPUT meter. Readjustment of L3 by means of the OUTPUT dial index rebalances the bridge to the proper reference value.

e. RT3 is a bolometer similar to RT2 but not subjected to the R.F. magnetic fields. Its purpose is to compensate for ambient temperature changes and minute changes in bridge driving voltage. See Fig. 2.

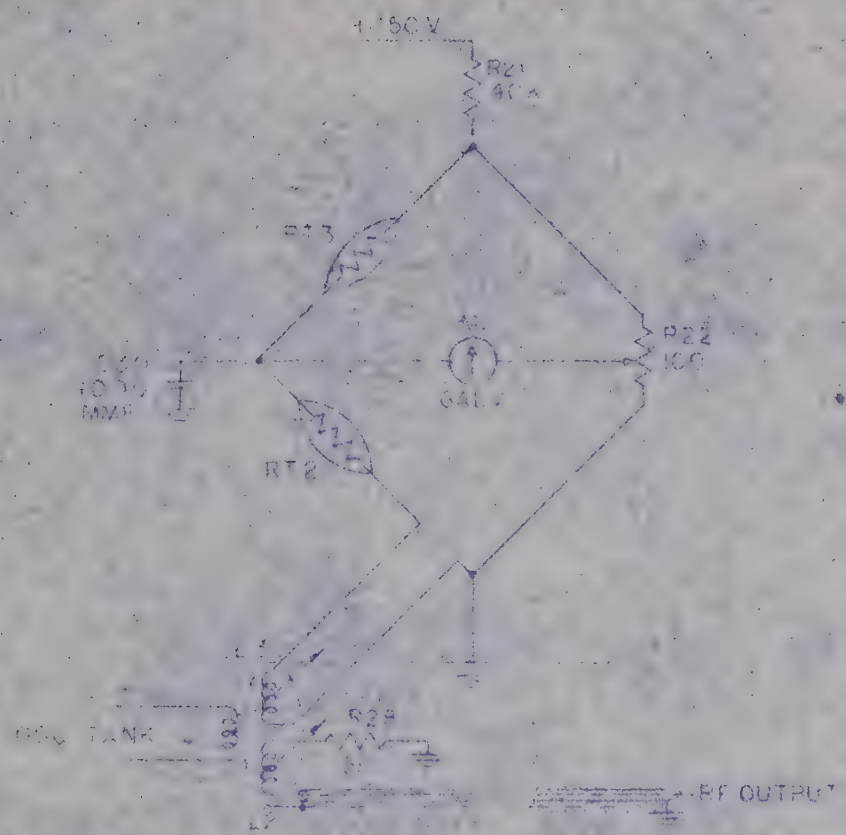


Figure 2. Simplified Output System.

29. POWER SUPPLY

a. Power transformer T1 supplies AC power to 6X4 tube V1 where it is rectified and filtered by R2, R3, R4 and C2A, C2B and C2C.

b. V2 (0A2) is a gaseous regulator tube which serves to hold the B+ supply voltage constant and provides additional filtering.

c. The 6.3V heater winding of T1 is rectified by CR1, filtered by C1 and applied to the R-F oscillator and reactance tube heaters via adjustable resistor R1.

d. V3a and V3b obtain heater voltage directly from the 6.3V winding of T1 and B+ voltage from a higher level at the junction of R2 and R3.

SECTION III

PRE-ADJUSTMENT PROCEDURE

30. GENERAL

a. The Model 210-S is a precision signal generator, carefully adjusted at the factory and no adjustments should be required. Due to the numerous adjustments, tampering with the internal controls should be avoided. Particular care should be exercised to avoid using an ohmmeter on the output circuits containing RT2, RT3 and galvanometer M1, as these elements may be easily permanently damaged by the application of currents in excess of 1 milliamp.

SECTION IV

TROUBLE LOCATION

31. GENERAL

a. Service in the field is not recommended; however, if absolutely necessary, trouble may be localized and a temporary repair effected by reference to the Trouble Shooting Chart, Table III.

b. Tube Voltage Chart, Table IV, shows typical tube voltages.

SECTION V

REPAIR PROCEDURES

32. GENERAL

a. Consult Trouble-Shooting Chart, Table III. If the remedy for the observed trouble calls for removal of instrument from case, follow instructions given in the following paragraph.

33. REMOVAL OF INSTRUMENT FROM CASE

a. To remove the Model 210-S from its case, unscrew the four rubber feet and the sealed screw in the cup washer on the bottom of the case. Remove the black binder head screws on the back of the case. Unscrew and remove the fuse cap located in the bottom of the instrument. The entire instrument may now be slid forward and out of its case.

SECTION VI

ADJUSTMENT PROCEDURES

34. GENERAL

a. Due to the large quantity of specialized equipment required to align and adjust a precision FM signal generator, repair procedures other than tube or simple component replacement, is not recommended.

APPENDIX I

STORAGE AND SHIPMENT

1. STORAGE

a. Remove dust from controls and outer surface of instrument with a clean rag.

b. Wrap instrument in heavy wrapping paper and seal seams with gummed tape or similar adhesive.

c. Store in a dry place. If excessive humidity is unavoidable, the wrapped instrument should be placed in a moisture-proof bag with a sufficient quantity of drying agent, such as silica gel, to insure a dry atmosphere. When the use of bag and desiccant is necessary, the instrument should be checked at six-month intervals to determine the effectiveness of the seal.

2. SHIPMENT

a. Wrap the instrument with heavy wrapping paper and seal seams with gummed tape or similar adhesive.

b. Place in fibre-board carton or wooden box large enough to permit at least three inches of excelsior or similar packing material between the instrument and sides of the box. For export packing, the instrument must be wrapped in waterproof paper and the seams sealed with waterproof glue or similar sealing compound before being placed in a wooden box.

APPENDIX II.

TABLE OF REPLACEABLE PARTS

Model 210-S Standard FM Signal Generator

Symbol	Meas. Corp. Part Number	Description
Capacitors		
C1	H-5576	Electro; 3000 mfd., 10 WVDC.
C2	H-5003	Electro; 20-20-20-20 mfd., 450 WVDC.
C3	H-5577	Electro; 5 mfd., 6 WVDC.
C4	H-5128	Mica; 1000 mmf., ± 1%.
C5	H-5578	Mica; 910 mmf., ± 1%.
C6	H-3755	Paper; .05 mfd., ± 20%, 600 WVDC.
C7	H-5579	Electro; 4 mfd., 450 WVDC.
C8	H-5566	Ceramic; feed-thru, 1500 mmf.
C9	H-5580	Ceramic; feed-thru, 55 mmf.
C10	H-5566	Ceramic; feed-thru, 1500 mmf.
C11	H-5566	Ceramic; feed-thru, 1500 mmf.
C12	H-5566	Ceramic; feed-thru, 1500 mmf.
C13	H-5566	Ceramic; feed-thru, 1500 mmf.
C14	H-5580	Ceramic; feed-thru, 55 mmf.
C15	H-5566	Ceramic; feed-thru, 1500 mmf.
C16	H-5566	Ceramic; feed-thru, 1500 mmf.
C17	H-5566	Ceramic; feed-thru, 1500 mmf.
C18	H-5566	Ceramic; feed-thru, 1500 mmf.
C19	H-5580	Ceramic; feed-thru, 55 mmf.
C20	H-5566	Ceramic; feed-thru, 1500 mmf.
C21	H-5566	Ceramic; feed-thru, 1500 mmf.
C22	H-5566	Ceramic; feed-thru, 1500 mmf.

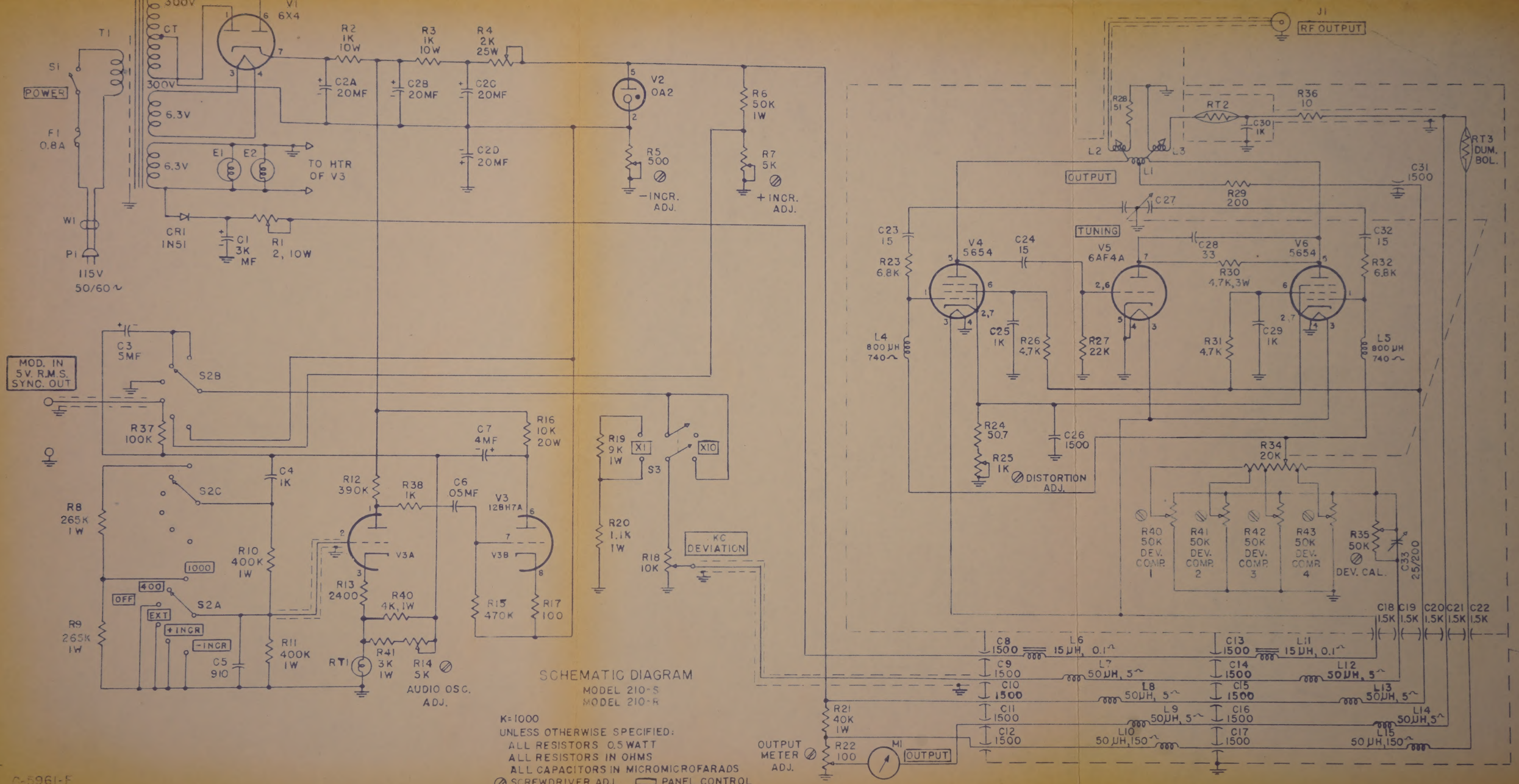
Symbol	Meas. Corp. Part Number	Description
C23	H-6334	Ceramic, 15 mmf. N750
C24	H-6334	Ceramic, 15 mmf. N750
C25	H-5500	Ceramic, 1000 mmf.
C26	H-5566	Ceramic, feed-thru, 1500 mmf.
C27	H-5975	Variable.
C28	H-6335	Ceramic, 33 mmf. N1500
C29	H-5500	Ceramic, 1000 mmf.
C30	H-5562	Ceramic, 1000 mmf.
C31	H-5566	Ceramic, feed-thru, 1500 mmf.
C32	H-6334	Ceramic, 15 mmf. N750
C33	H-6331	Variable, 25-200 mmf.
Rectifier		
CR1		#1N151
Lamp		
E2	H-5582	6 volts.
E1	H-5582	In Meter M1.
Fuse		
F1	H-5018-8	8/10 amp.
Connector		
J1		UG-1052/U

Symbol	Meas. Corp. Part Number	Description
Coils		
L1	H-5863-6	Oscillator Coil.
L2	H-5964-1	Pick-Up coil. Output.
L3	H-5964-2	Pick-Up Coil. Sampling.
Chokes		
L4	H-5864	800 microhenries, ± 20%, D.C. resistance 740 ohms, ± 20%.
L5	H-5864	800 microhenries, ± 20%, D.C. resistance 740 ohms, ± 20%.
L6	H-5538	15 microhenries, ± 20%, D.C. resistance 0.12 ohms, ± 20%.
L7	H-5880	50 microhenries, ± 20%, D.C. resistance 3.5 ohms, ± 20%.
L8	H-5880	50 microhenries, ± 20%, D.C. resistance 3.5 ohms, ± 20%.
L9	H-5880	50 microhenries, ± 20%, D.C. resistance 3.5 ohms, ± 20%.
L10	H-5879	50 microhenries, ± 5%, D.C. resistance 150 ohms.
L11	H-5538	15 microhenries, ± 20%, D.C. resistance 0.12 ohms, ± 20%.
L12	H-5880	50 microhenries, ± 20%, D.C. resistance 3.5 ohms, ± 20%.
L13	H-5880	50 microhenries, ± 20%, D.C. resistance 3.5 ohms, ± 20%.
L14	H-5880	50 microhenries, ± 20%, D.C. resistance 3.5 ohms, ± 20%.
L15	H-5879	50 microhenries, ± 5%, D.C. resistance 150 ohms.
Meter		
M1	H-955	50-0-50 uA Galvanometer.
P1		Plug, Part of W1.

Symbol	Meas. Corp. Part Number	Description
Resistors		
R1	H-5595	Adj., w.w., 2 ohms, ± 10%, 10 watts.
R2	H-5118	Fixed; w.w., 1000 ohms, ± 10%, 10 watts.
R3	H-5118	Fixed; w.w., 1000 ohms, ± 10%, 10 watts.
R4	H-6603	Adj., w.w., 2000 ohms, ± 10%, 25 watts.
R5	H-5521-2	Var.; w.w., 500 ohms, scr. dr. adjust.
R6	H-3745-16	Fixed; metal film, 50,000 ohms, ± 2%, 1 watt.
R7	H-5362	Var.; w.w., 5000 ohms, scr. dr. adjust.
R8	H-3745-30	Fixed; metal film, 265,000 ohms, ± 2%, 1 watt.
R9	H-3745-30	Fixed; metal film, 265,000 ohms, ± 2%, 1 watt.
R10	H-3745-32	Fixed; metal film, 400,000 ohms, ± 2%, 1 watt.
R11	H-3745-32	Fixed; metal film, 400,000 ohms, ± 2%, 1 watt.
R12	H-3728-394	Fixed; comp., 390,000 ohms, ± 10%, 1/2 watt.
R13	H-3727-242	Fixed; comp., 2,400 ohms, ± 5%, 1/2 watt.
R14	H-5362	Var., w.w., 5,000 ohms, scr. dr. adjust.
R15	H-3728-474	Fixed; comp., 470,000 ohms, ± 10%, 1/2 watt.
R16	H-5352	Fixed; w.w., 10,000 ohms, ± 10%, 20 watt.
R17	H-3728-101	Fixed; comp., 100 ohms, ± 10%, 1/2 watt.

Symbol	Meas. Corp. Part Number	Description
Resistors - Cont.		
R18	H-5584	Var., w.w., 10,000 ohms.
R19	H-3745-7	Fixed; metal film, 9,000 ohms, ± 1%, 1 watt.
R20	H-3745-41	Fixed; metal film, 1110 ohms, ± 1%, 1 watt.
R21	H-3745-14	Fixed; metal film, 40,000 ohms, ± 2%, 1 watt.
R22	H-5585	Var., w.w., 100 ohms, scr. dr. adjust.
R23	H-3727-682	Fixed; comp., 6800 ohms, ± 5%, 1/2 watt.
R24	H-4882-16	Fixed; metal film, 50.7 ohms, ± 5%, 1/2 watt.
R25	H-5544	Var.; w.w., 1000 ohms, scr. dr. adjust.
R26	H-3728-472	Fixed; comp., 4700 ohms, ± 10%, 1/2 watt.
R27	H-3728-223	Fixed; comp., 22,000 ohms, ± 10%, 1/2 watt.
R28	H-3727-510	Fixed; 51 ohms, ± 5%, 1/2 watt.
R29	H-3728-201	Fixed; comp., 200 ohms ± 10%, 1/2 watt.
R30	H-6332-3	Fixed; w.w., 4700 ohms, ± 5%, 3 watt.
R31	H-3728-472	Fixed; comp., 4700 ohms, ± 10%, 1/2 watt.
R32	H-3727-682	Fixed; comp., 6800 ohms ± 5%, 1/2 watt.
R33		
R34	H-5972	Var.; w.w., 20,000 ohms.
R35	H-6336	Var.; comp., 50,000 ohms, scr. dr. adjust.

Symbol	Meas. Corp. Part Number	Description
Resistors - Cont.		
R36	H-5886	Fixed; w.w., 10 ohms approx.
R37	H-3728-104	Fixed; comp., 100,000 ohms, ± 10%, 1/2 watt.
R38	H-3728-102	Fixed; comp; 1,000 ohms, ± 10%; 1/2 watt.
R39		
R40	H-6336	Var; comp; 50,000 ohms, scr. dr. adjust.
R41	H-6336	Var; comp; 50,000 ohms, scr. dr. adjust.
R42	H-6336	Var; comp; 50,000 ohms, scr. dr. adjust.
R43	H-6336	Var; comp; 50,000 ohms, scr. dr. adjust.
Lamp Regulator & Bolometers		
RT1	H-5052	3 watt, 120 volts.
RT2	H-710) Matched	Bolometer
RT3	H-710) Pair	Bolometer
Switches		
S1	H-383-1	Toggle, SPST.
S2	H-5873	Rotary.
S3	H-383-4	Toggle, DPDT.
Transformers		
T1	H-5405	Power.
Tubes		
V1		Electron, RETMA, 6X4.
V2		Electron, RETMA, 0A2.
V3		Electron, RETMA, 12BH7
V4		Electron, RETMA, 5654.
V5		Electron, RETMA, 6AF4A.
W1	H-704	Power Cord



SCHEMATIC DIAGRAM

MODEL 210-S

MODEL 210-R

K=1000

UNLESS OTHERWISE SPECIFIED:

ALL RESISTORS 0.5 WATT

ALL RESISTORS IN OHMS

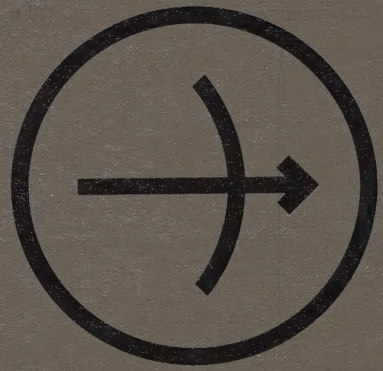
ALL CAPACITORS IN MICROMICROFARADS

⊘ SCREWDRIVER ADJ. ▭ PANEL CONTROL

C-5961-F

MEASUREMENTS

BOX 180, BOONTON
NEW JERSEY



MP MASTER
MA24357